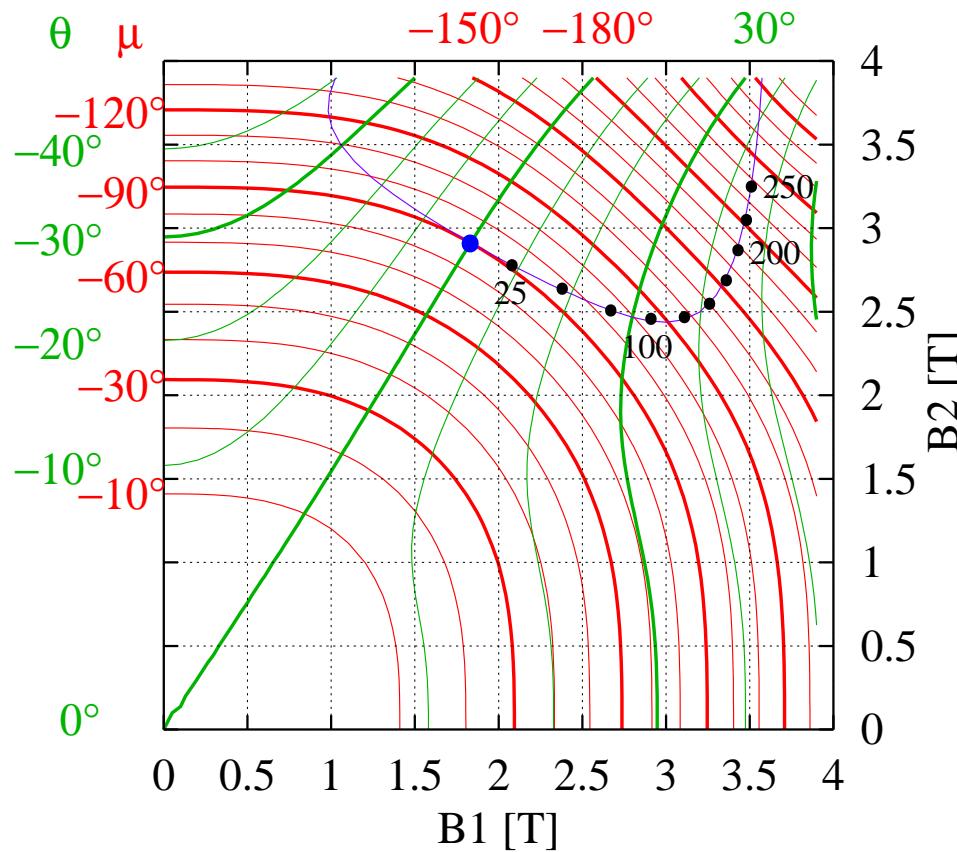


§ Outline §

- Rotators at injection experiment – status
- Spin decoherence experiment – status
 - RHIC Basic idea: 1, 2, 2.5 snakes in RHIC
 - AGS problem to study: radial polarization at $G\gamma = 46$
- Vert-long coupling in AGS proposal
- RHIC Snake calibration proposal

⚡ Rotators at injection ⚡



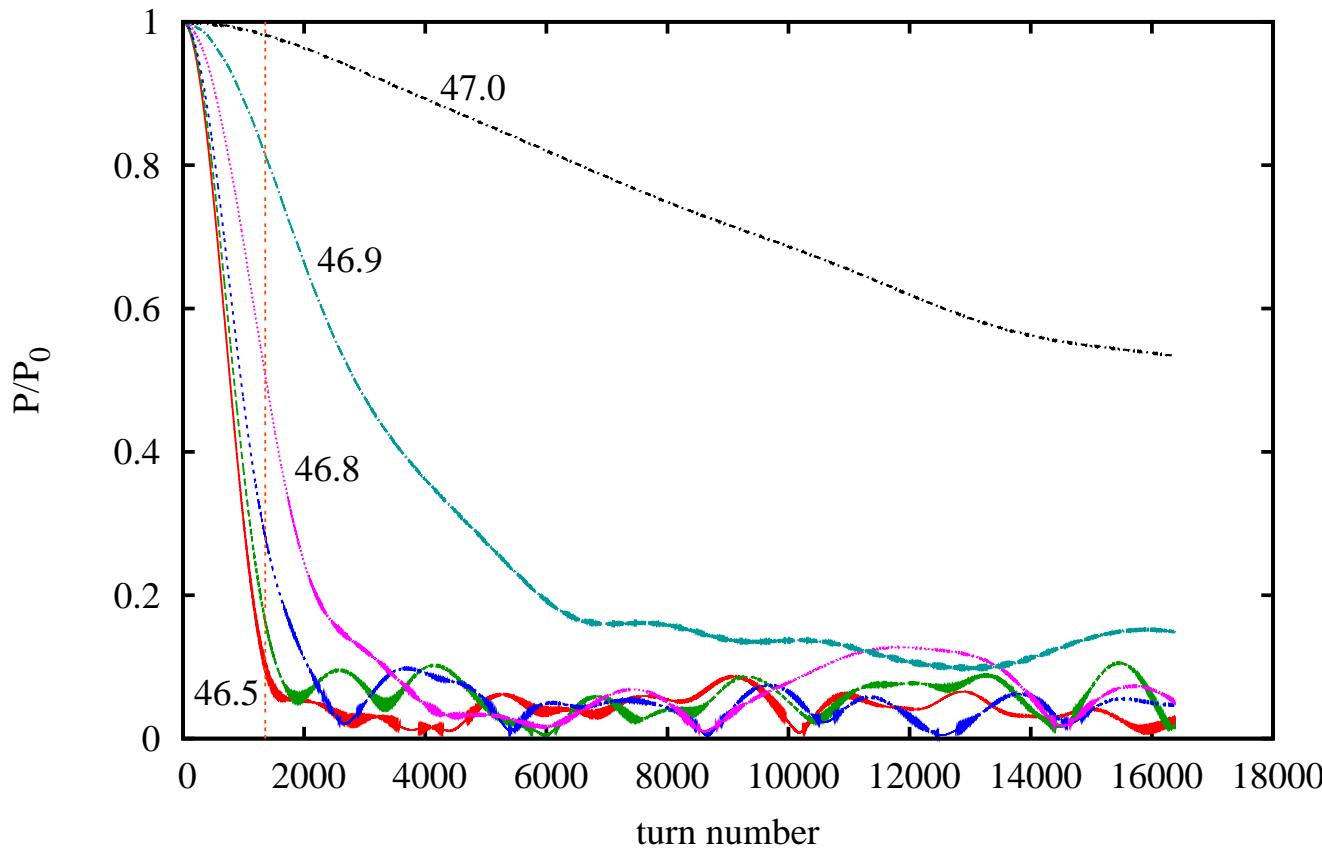
- Blue dot corresponds to 50% snake.
 - No horizontal offsets required.
 - Would not shift spin tune.
 - Halves ramp time to 250GeV.
 - Pol. with even single rotator.
- Full rotators: require horiz bumps.
 - Would shift spin tune.
- Future development: on hold.
 - Energy calibration on hold.

↳ Spin Decoherence ↳

- Inject with $\vec{P} \perp \vec{n}_0$.
- FFT of turn-by-turn polarization measurement.
- RHIC Simulations with longitudinal oscillations
 - 1 snake: calibrate rotation angle μ
 - Short decoherence times
 - 2 snakes: calibrate snake axis angles ϕ
 - Long decoherence times
 - Requires injecting with horiz polarization
 - 2.5 snakes: test spin tune measurement
 - Only one session of setup.
 - No ν_{sp} measurements yet.
- Ref: W. W. MacKay, “On the Feasibility of a Spin Decoherence Measurement”, *Proc. of EPAC 2006*, Edinburgh, 276(2006).



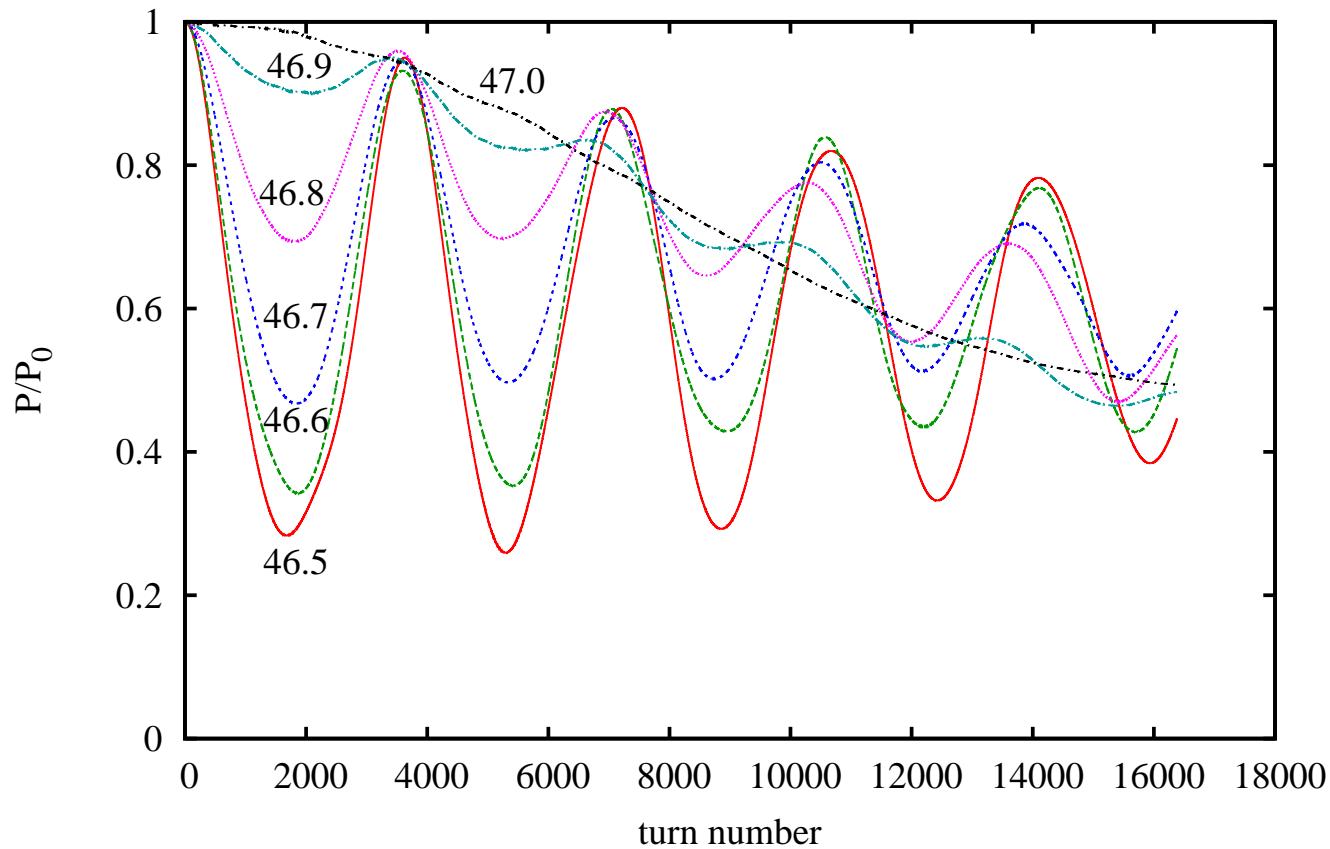
One Snake — no Synchrotron Osc.



At $G\gamma=46.5$

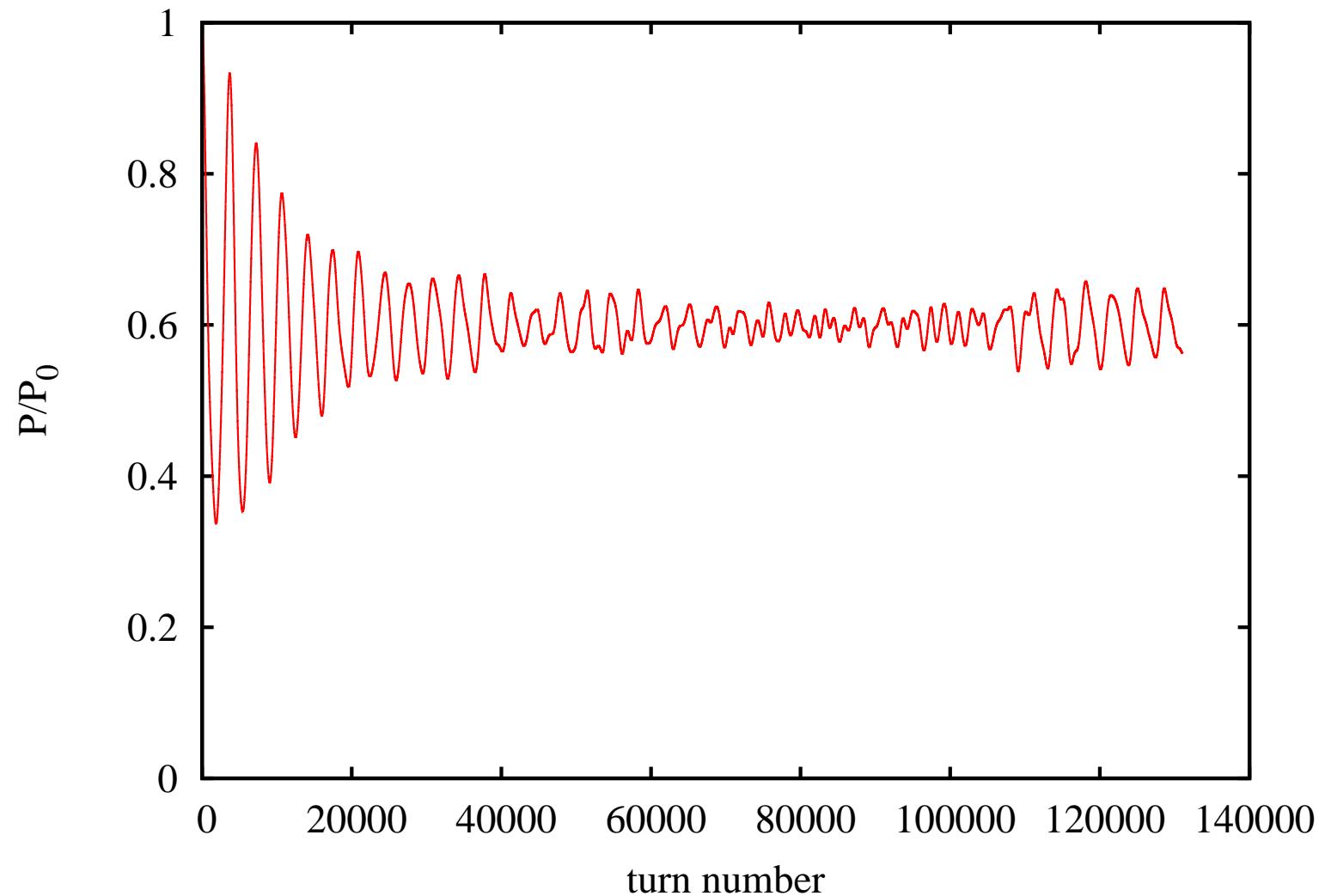
$$N_{\text{dec}} \simeq \frac{1}{\pi \xi_{\text{sp}} (\sigma_p/p)}$$

One Snake with Synch Osc.

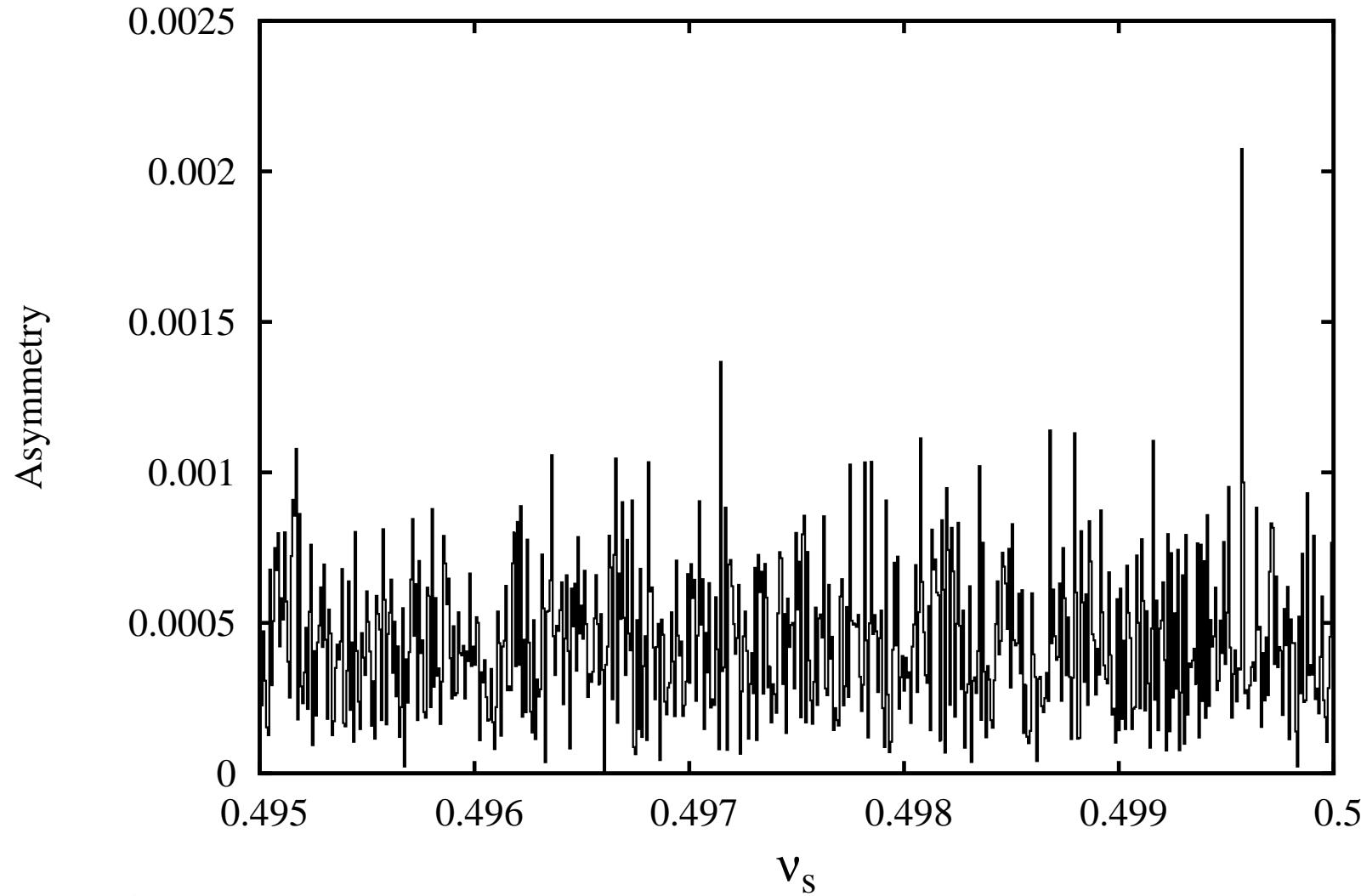


$$\frac{1}{Q_{\text{sy}}} \simeq 1360 \text{ turns.}$$

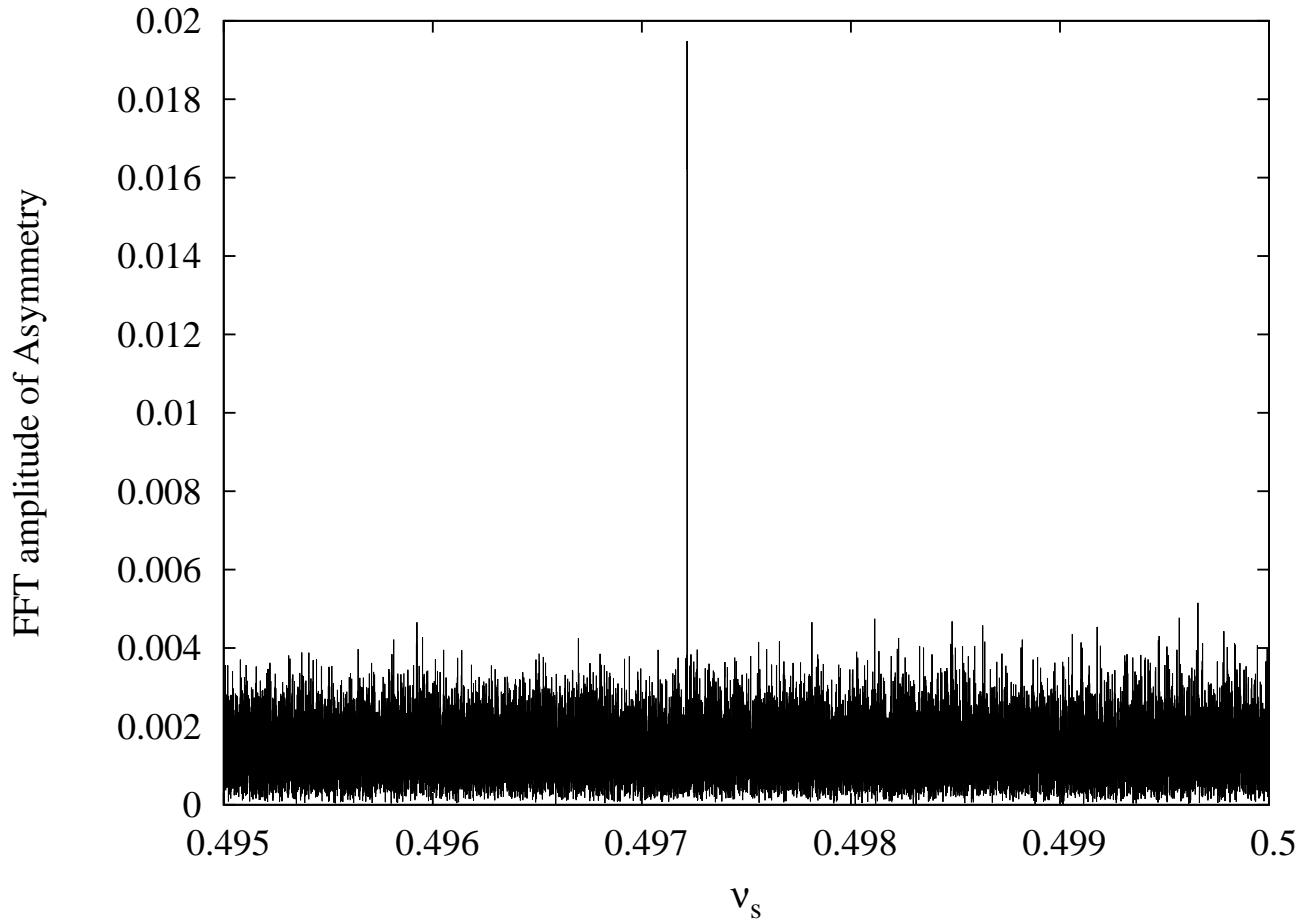
♪ Total polarization with 1 detuned snake ♪



♪ Sim. of polarimeter: 1 snake ♪



♪ Two snakes slightly detuned (Sim.) ♪



Want horiz injection:

$$G\gamma = 46.95$$

$$\mu = 179.5^\circ$$

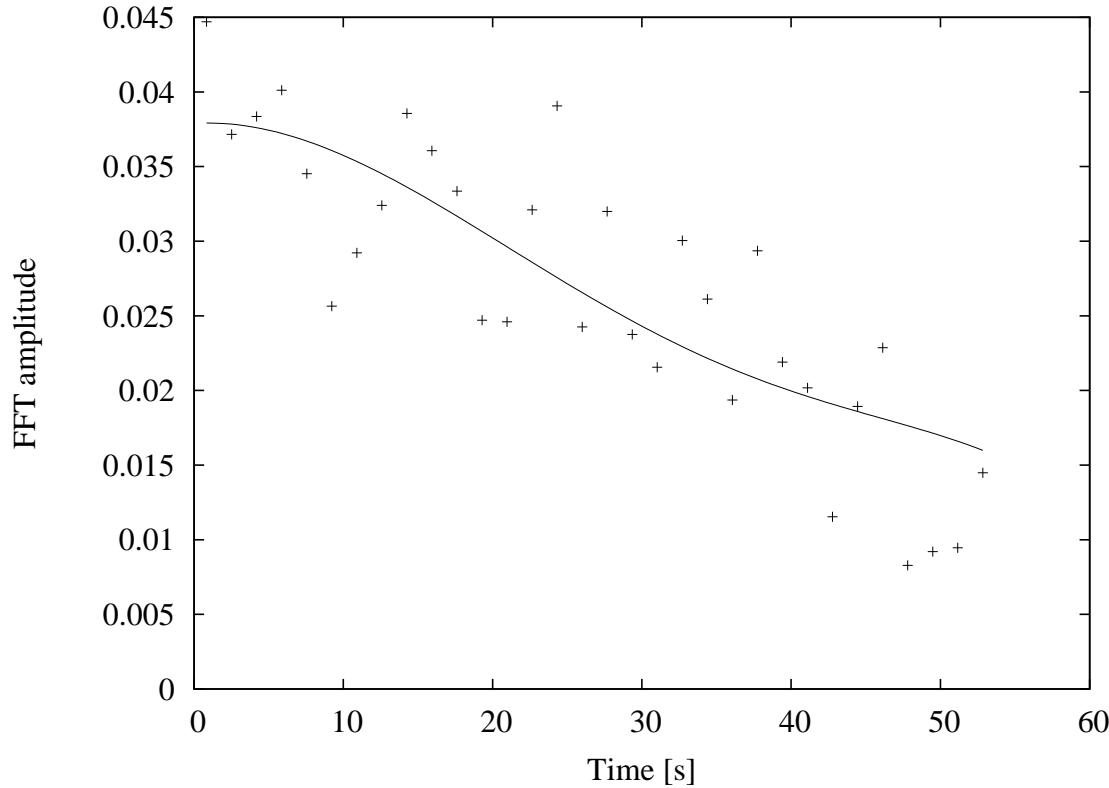
$$\Delta\phi = 90.5^\circ$$

30 bunches
 2^{22} turns

$$P_0 = 50\%$$

$$\nu_s = 0.497216$$

Spin decoherence with two snakes.



(Simulation)

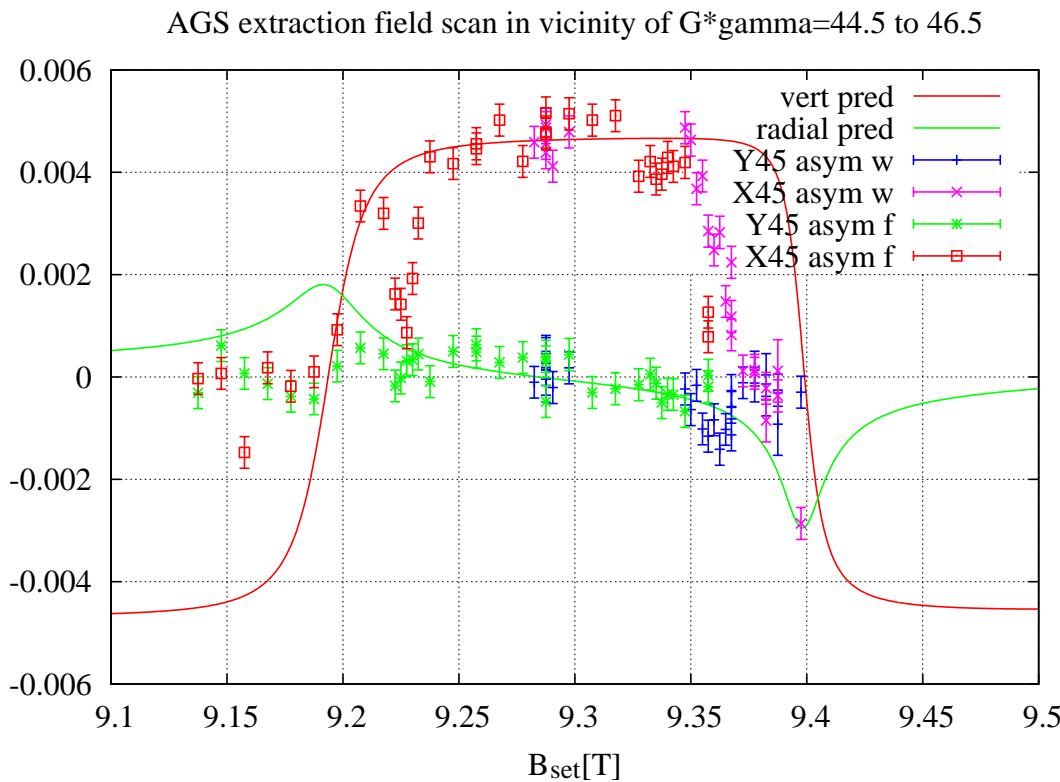
Segment data into 2^{17} -turn bins

Curve: average P scaled to fit

factor = 0.0380 ± 0.0013

Can beam be extracted from AGS polarized in horizontal plane?

♪ Radial Polarization in AGS ♪

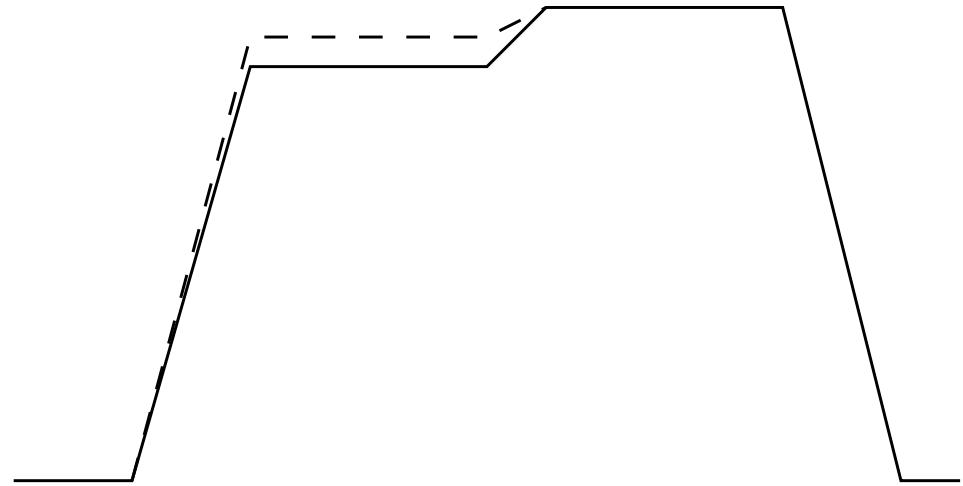


- No radial Pol. at $G\gamma = 46$ (or at $G\gamma = 45$)
- Is this:
 - too slow a res. Xing?
 - decoherence?
 - or just an open \vec{n} -field?

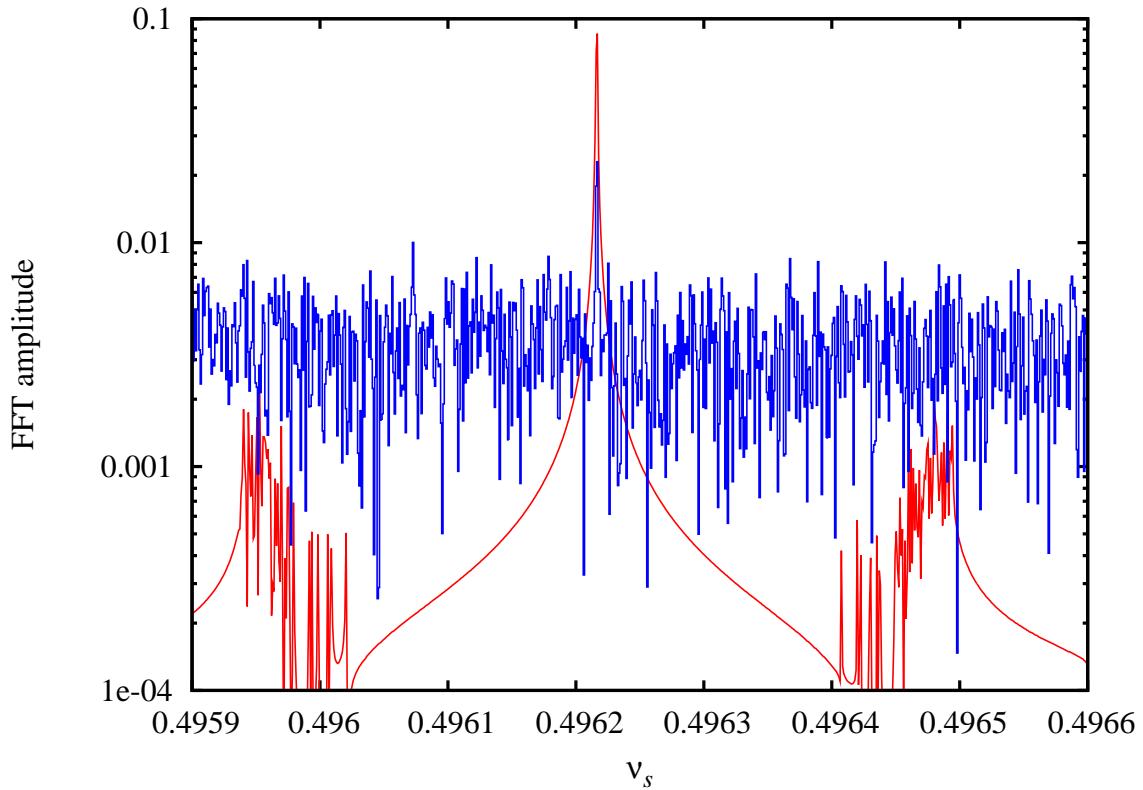
Scans by Fanglei and Waldo

↳ AGS proposal: Radial Polarization ↳

- Special ramp function
- Two 1 s flattop values
 - Second at $G\gamma = 46.5$
 - Scan first flattop from 45.5 to 46.5
- Measure pol. on both flattops.
 - Eliminates question of open \vec{n} -field.



RHIC: Two and a half snakes



Red: FFT of simulated P_v

Blue: FFT of Monte Carlo-ed polarimeter data.

Add a 50% snake:

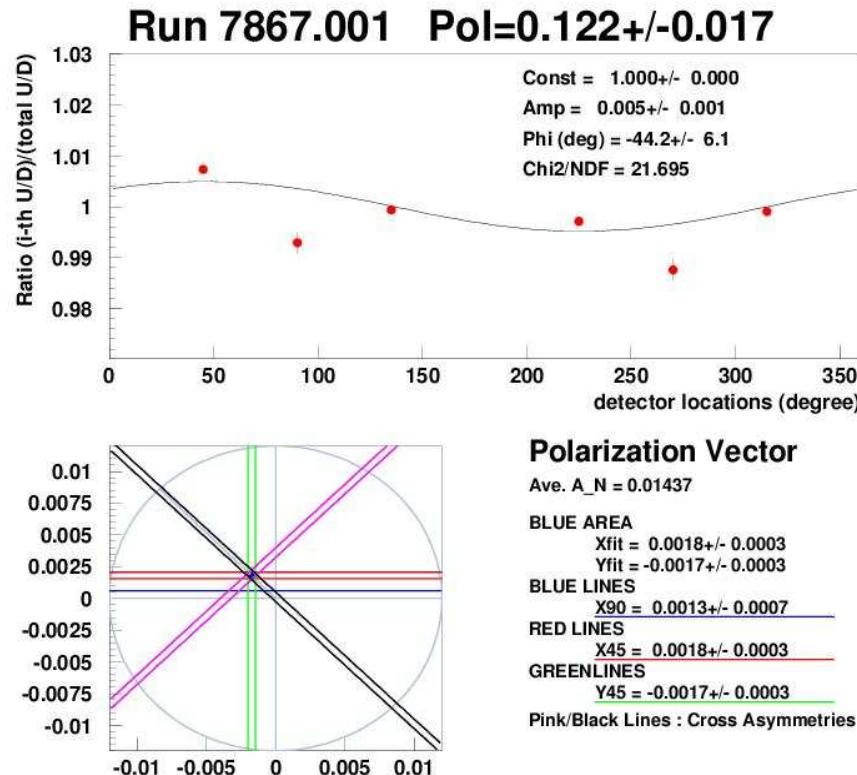
Use a spin rotator
 \vec{n}_0 at 45° to vert.

Assume 1 event per turn.

50 bunches

thick target

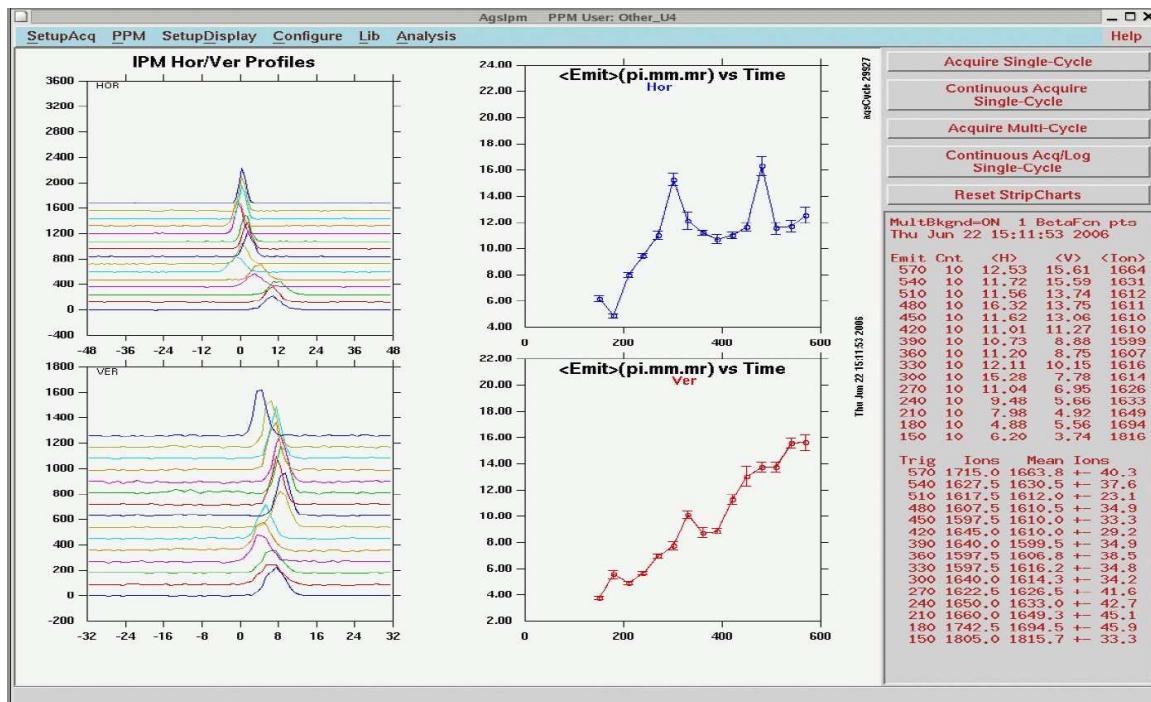
RHIC Polarization with 2.5 snakes



- Only one APEX session for rotator setup.
- Second session canceled due to Abort Kicker failure.

Vert-Long Coupling: Motivation

- AGS protons: operate with $Q_v = 9 - \epsilon$
- Motivation: vertical emittance growth:



From Leif's Retreat presentation

Possibilities:

- $Q_v = \text{integer}$
 - Growth appears linear
- $Q_v \pm Q_{sy} = \text{integer}$
- something else:
 - nonlinearities
 - noise
 - ?

Two basic ways to get yz-coupling

- Vertical bends generating vertical dispersion.
 - Basically a 2-d problem like horizontal dispersion.
 - $Q_v - Q_{sy} = N$ generally stable.
 - $Q_v + Q_{sy} = N$ generally unstable.
- xy -coupling leading to vertical dispersion.
 - This is a 3-d effect.
 - Simple simulations show both $Q_v \pm Q_{sy} = N$ can be stable.
- For Q_v just below the integer we have:
 - $Q_v + Q_{sy} = 9$ below transition.
 - $Q_v - Q_{sy} = 9$ above transition.

AGS Max Synchrotron Tune

Ion		γ	Q_{sy}	f_{sy} [Hz]
p	inj	2.51	0.0065	2200
p	ext	25.38	0.00053	200
$^{197}\text{Au}^{+79}$	inj	1.11	0.031	5000
$^{197}\text{Au}^{+79}$	ext	10.30	0.00030	110

$$V_{rf} = 300\text{kV}$$

$$h = 12$$

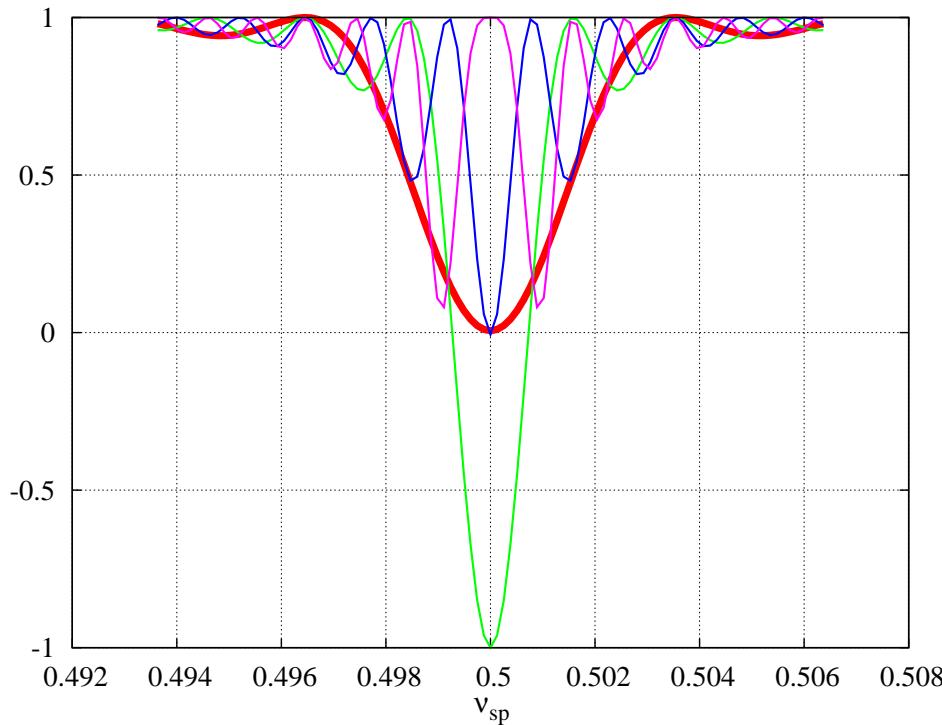
$$\gamma_t = 8.7$$

- Gold at injection looks good for studies.
 - Explore with $Q_v = 9 \pm \epsilon$.

RHIC Snake Calib at Injection

- Use AC dipole
 - set $Q_{\text{acdip}} = 1/2$
 - pulse to rotate spin by about 90° away from vertical.
 - measure P_{vert}
 - repeat with different snake axes settings to peak up rotation.
 - repeat with narrower resolutions.
- For simplicity, assume square pulse (violates adiabaticity)
 - $N = G\gamma \frac{qBl}{p} = \frac{\pi}{2}$
 - resolution $\sigma_\nu \sim \frac{1}{N}$
- SPINK tracking can estimate correction for vertical betatron contribution.

♪ AC dipole rotation vs strength ♪



- Scan of snake axes (in ν_{sp})
 - Red: 1×strength for 90°
 - Green: 2×strength
 - Blue: 3×strength
 - Magenta: 4×strength
- Best between 1× and 2×.

Summary

- Rotators at Injection: Significant progress, but on hold.
- Spin decoherence: Lack of running time.
 - Spawned a new proposal for AGS study.
 - Need replacement for Jeff Woods.
- Vert-long coupling in AGS: NEW Idea.
 - Study easiest at AGS injection with gold ions.
- New proposal: RHIC snake calibration at injection.



APEX Workshop: 3 November, 2006
Waldo MacKay